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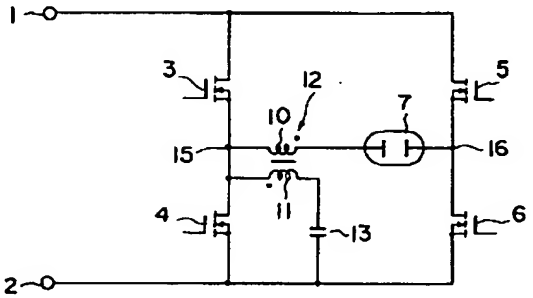
(54)【考案の名称】　放電灯用点灯回路

(57)【要約】
【目的】　放電灯用点灯回路の回路構成を簡素化しかつ部品点数を削減する。
【構成】　本考案による放電灯用点灯回路は、複数のスイッチング素子としての第１～第４のＦＥＴ３～６で構成されたブリッジ回路の出力端子１５、１６間にリアクトル１２の１次巻線１０と放電灯７とを直列に接続し、リアクトル１２の２次巻線１１にコンデンサ１３を接続して共振回路を形成している。高圧のトリガパルスを発生する回路をリアクトル１２の２次巻線１１及びコンデンサ１３で構成できるので、回路構成を簡素化することが可能となり部品点数を削減することができる。



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【実用新案登録請求の範囲】

【請求項１】　複数のスイッチング素子で構成されたブリッジ回路の出力端子間にリアクトルと放電灯とを直列に接続した放電灯用点灯回路において、

前記リアクトルにコンデンサを接続して共振回路を形成したことを特徴とする放電灯用点灯回路。

【請求項２】　前記リアクトルは１次巻線と２次巻線とを有する「請求項１」に記載の放電灯用点灯回路。

【図面の簡単な説明】

【図１】　本考案の実施例を示す放電灯用点灯回路の電気回路図

【図２】　各ＦＥＴ（電界効果トランジスタ）のドレイ＊

2

＊ンーソース間の電圧を示す波形図

【図３】　１次巻線、２次巻線及び放電灯の各両端の電圧を示す波形図

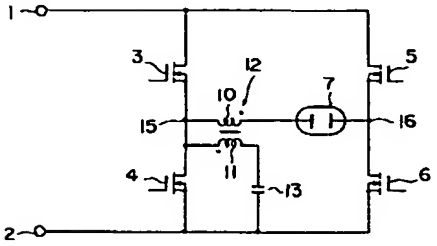
【図４】　本考案の他の実施例を示す放電灯用点灯回路の電気回路図

【図５】　従来の放電灯用点灯回路を示す電気回路図

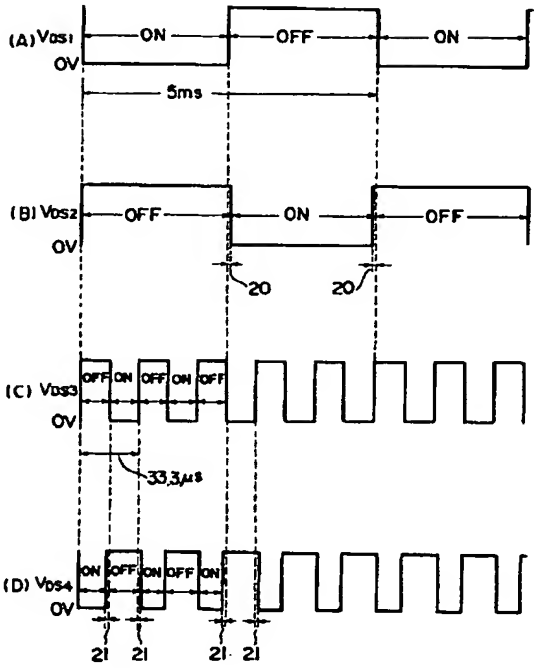
【符号の説明】

１、２．．入力端子、３～６．．第１～第４のＦＥＴ（スイッチング素子）、７．．放電灯、８、１２、１４．．リアクトル、９．．トリガ発生回路、１３．．コンデンサ、１５、１６．．出力端子

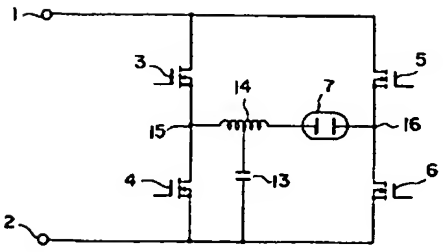
【図１】



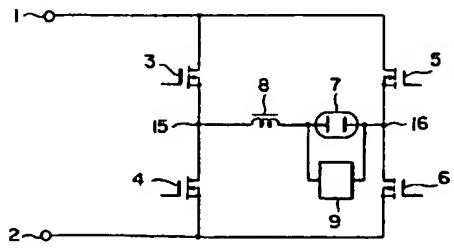
【図２】



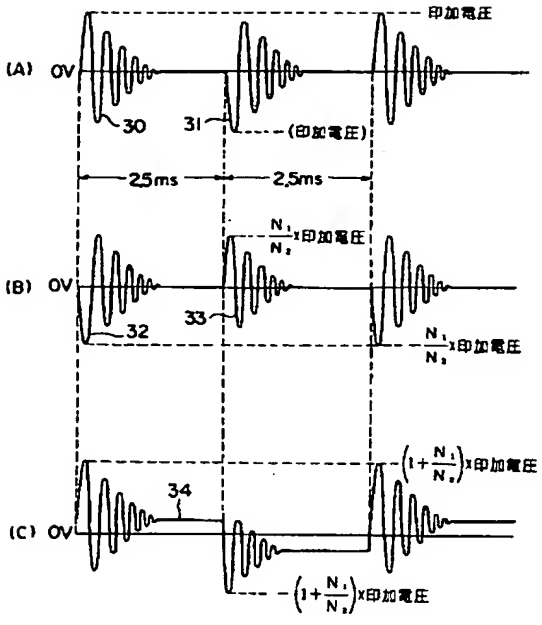
【図４】



【図５】



【図3】


印加電圧
(A) 0V
30
31
(印加電圧)
2.5ms
2.5ms
$\frac{N_1}{N_2}$×印加電圧
(B) 0V
32
33
$\frac{N_1}{N_2}$×印加電圧
$\left(1+\frac{N_1}{N_2}\right)$×印加電圧
34
(C) 0V
$-\left(1+\frac{N_1}{N_2}\right)$×印加電圧

【考案の詳細な説明】

【０００１】

【産業上の利用分野】

本考案はメタルハライドランプ（ＨＩＤランプ）、水銀灯等の放電灯用点灯回路に関するものである。

【０００２】

【従来の技術】

従来の放電灯用点灯回路は例えば図５に示すように、複数のスイッチング素子としての第１～第４のＦＥＴ（電界効果トランジスタ）３～６で構成されたブリッジ回路の出力端子１５、１６間にリアクトル８と放電灯７とが直列に接続されている。放電灯７にはトリガ発生回路９が並列に接続されている。

【０００３】

ブリッジ回路の入力端子１、２間に直流電圧を印加すると共に第１及び第４のＦＥＴ３、６と第２及び第３のＦＥＴ４、５とを交互にオン・オフ動作させてブリッジ回路の出力端子１５、１６間に矩形波電圧を発生させる。これと同時にトリガ発生回路９により４ｋＶ以上のトリガパルス電圧を放電灯７に印加して放電灯７を点弧させ、放電灯７及びリアクトル８に矩形波電流を流して放電灯７を点灯させる。リアクトル８は放電灯７に流れる矩形波電流の高周波成分を阻止して放電灯７の光出力の安定化を図るものである。

【０００４】

【考案が解決しようとする課題】

ところで、従来の放電灯用点灯回路では、放電灯７を点弧させるために４ｋＶ以上のトリガパルス電圧を発生するトリガ発生回路９を別個に必要とするので、回路構成が複雑で部品点数が多くなり、小型化及び軽量化が困難である欠点があった。この欠点は製造コスト低減の障害となっており、好ましくない。

【０００５】

そこで、本考案は回路構成を簡素化できかつ部品点数を削減できる放電灯用点灯回路を提供することを目的とする。

【０００６】

【課題を解決するための手段】

本考案による放電灯用点灯回路は、複数のスイッチング素子で構成されたブリッジ回路の出力端子間にリアクトルと放電灯とを直列に接続し、前記リアクトルにコンデンサを接続して共振回路を形成している。図示の実施例のリアクトルは1次巻線と2次巻線とを有する。

【0007】

【作用】

複数のスイッチング素子で構成されたブリッジ回路の入力端子間に直流電圧を印加すると共に複数のスイッチング素子をそれぞれ交互にオン・オフ動作させてブリッジ回路の出力端子間に矩形波電圧を発生させると、矩形波電圧の立上り時及び立ち下がり時に同期したインパルス電流がリアクトル及びコンデンサで構成された共振回路に流れる。このインパルス電流によって共振回路が共振して高圧のトリガパルスを発生し、放電灯に印加される。これによって、放電灯が点弧されると同時に放電灯及びリアクトルに矩形波電流が流れ、放電灯が点灯する。このため、高圧のトリガパルスを発生する別個の回路が不要となり、回路構成を簡素化できかつ部品点数を削減することができる。

【0008】

【実施例】

以下、本考案による放電灯用点灯回路の実施例を図1～図3に基づいて説明する。但し、図1では図5に示す箇所と同一の部分には同一の符号を付し、その説明を省略する。

本実施例の放電灯用点灯回路は、図1に示すように、入力端子1、2間に第1及び第2のＦＥＴ（電界効果トランジスタ）3、4の直列回路が接続され、第1及び第2のＦＥＴ3、4の直列回路と並列に第3及び第4のＦＥＴ5、6の直列回路が接続されている。これによって、第1のＦＥＴ3のソース端子と第2のＦＥＴ4のドレイン端子との接合点及び第3のＦＥＴ5のソース端子と第4のＦＥＴ4のドレイン端子との接合点を出力端子15、16とするブリッジ回路が形成される。第1～第4のＦＥＴ3～6はスイッチング素子として使用し、それぞれのＦＥＴのゲート端子に電圧を印加することによりオフ状態からオン状態となる

。本実施例では、図2(A)、(B)に示すように第1及び第2のＦＥＴ3、4を200Hz程度の周波数、即ち5msの周期で交互にオン・オフ動作させ、図2(C)、(D)に示すように第3及び第4のＦＥＴ5、6を30kHz程度の周波数、即ち33・3μsの周期で交互にオン・オフ動作させている。第1～第4のＦＥＴ3～6のドレインーソース間電圧V_{DS1}～V_{DS4}は0Vのときはオン状態を示し、高レベル電圧のときはＦＥＴがオフ状態を示している。このようにして、ブリッジ回路の出力端子15、16間に200Hz程度の矩形波電圧を発生させる。なお、図2に示すように、第1及び第2のＦＥＴ3、4と第3及び第4のＦＥＴ5、6のそれぞれのオン・オフ切り替わり時に同時にオン状態、即ち電源短絡状態となることを防止するために、ＦＥＴ3、4とＦＥＴ5、6をそれぞれ一定時間同時にオフ状態とするデッドタイム20、21を設けている。また、出力端子15、16間にはリアクトル12の1次巻線10と放電灯7とが直列に接続されている。放電灯7には、例えばビデオプロジェクタ用ランプとして使用されるメタルハライドランプ（ＨＩＤランプ）や水銀灯等の放電電極を有するものが使用される。出力端子15及び入力端子2間にはリアクトル12の2次巻線11とコンデンサ13が直列に接続され共振回路を形成している。リアクトル12の1次巻線10と2次巻線11の巻回方向は互いに逆、即ち相互インダクタンスが負の値となる巻回方向である。また、1次巻線10と2次巻線11の巻数比はN_1：N_2であり、$N_1 > N_2$の関係がある。

【0009】

次に、図1の放電灯用点灯回路の動作を図2及び図3に基づいて説明する。

入力端子1、2に200～300V程度の直流電圧を印加し、第1及び第4のＦＥＴ3、6をオン状態にすると、第1のＦＥＴ3、リアクトル12の2次巻線11、コンデンサ13の経路で電流が流れる。この電流の波形はインパルス波形であり、極めて僅かな時間しか流れない。このインパルス電流がリアクトル12の2次巻線11及びコンデンサ13に流れて共振することにより、リアクトル12の2次巻線11の両端には図3(A)に示すように、最大波高値が印加電圧に等しい交流電圧30が発生する。また、第2及び第3のＦＥＴ4、5がオン状態に切り替わる時には、コンデンサ13に蓄えられたエネルギをリアクトル12の2

次巻線１１、第２のＦＥＴ４の経路で放出するため、最大波高値が印加電圧に等しく交流電圧３０とは逆位相の交流電圧３１が発生する。このとき、リアクトル１２の１次巻線１０の両端には図３(Ｂ)に示すように、図３(Ａ)とは逆位相で最大波高値が印加電圧のN_1/N_2倍（$N_1/N_2>1$）の交流電圧３２、３３が発生する。リアクトル１２の１次巻線１０の両端に発生した交流電圧３２、３３により高圧のトリガパルスが生成され、放電灯７に印加されて放電灯７が点弧される。

【００１０】

放電灯７が点弧されると同時に、図２(Ａ)～(Ｄ)に示すように第１～第４のＦＥＴ３～６をオン・オフ動作させると、図２(Ａ)の最初の半周期（２･５ｍs）には、第１のＦＥＴ３、リアクトル１２の１次巻線１０、放電灯７、第４のＦＥＴ６の順で経由する方向の電圧が出力端子１５、１６間に発生する。ここで、この方向の電圧を正方向の電圧とすると、図２(Ａ)の次の半周期には、第３のＦＥＴ５、放電灯７、リアクトル１２の１次巻線１０、第２のＦＥＴ４の順で経由する方向の電圧、即ち負方向の電圧が出力端子１５、１６間に発生する。これによって、２００Ｈz程度の矩形波交流電圧が出力端子１５、１６間に発生し、放電灯７及びリアクトル１２の１次巻線１０に矩形波交流電流が流れ、放電灯７が点灯する。このときに放電灯７に印加される電圧は出力端子１５、１６間の電圧からリアクトル１２の１次巻線１０の電圧降下分（図３(Ｂ)）を差し引いた電圧であるから、放電灯７の電圧の最大波高値は次の式で与えられる。図３(Ｃ)に放電灯７の両端の電圧波形３４を示す。

【数１】

$$\left(1+\frac{N_1}{N_2}\right)\times\text{印加電圧}$$

なお、図２(Ａ)の１周期（５ｍs）間では、図２(Ｃ)及び(Ｄ)に示すように第３及び第４のＦＥＴ５、６が３３･３μsの周期で交互にオン・オフ動作しているが、リアクトル１２の１次巻線１０の自己誘導作用により出力端子１５、１６間の電圧が断続的になることはない。

【００１１】

上記のように、本実施例では高圧のトリガパルスを発生する回路をリアクトル１２の２次巻線１１及びコンデンサ１３で構成できるので、回路構成を簡素化することが可能となり部品点数を削減することができる。

【００１２】

本考案の実施態様は前記の実施例に限定されず種々の変更が可能である。例えば、図示の例では、第１及び第２のＦＥＴ３、４と第３及び第４のＦＥＴ５、６をそれぞれ２００Ｈｚ、３０ｋＨｚ程度の周波数で交互にスイッチング動作させる例を示したが、第１及び第３のＦＥＴ３、５と第２及び第４のＦＥＴ４、６をそれぞれ２００Ｈｚ、３０ｋＨｚ程度の周波数で交互にスイッチング動作させてもよい。それぞれのスイッチング周波数が２００Ｈｚ、３０ｋＨｚ程度に限定されないことは云うまでもない。第１～第４のＦＥＴ３～６のスイッチング周波数を全て同一としてもよい。また、ＦＥＴ（電界効果トランジスタ）の代わりに、通常の接合型パワートランジスタ、ＳＣＲ（逆阻止３端子サイリスタ）等の他のスイッチング素子を使用してもよい。更に、前記の実施例では、１次巻線１０及び２次巻線１１を有するリアクトル１２を使用する例を示したが、図４に示すように、中間タップを有するリアクトル１４を使用して中間タップにコンデンサ１３を接続してもよい。

【００１３】

【考案の効果】

本考案によれば、回路構成が簡素で部品点数の少ない放電灯用点灯回路を得ることができるので、点灯回路を小型化及び軽量化して製造コストを低減することが可能となる。

* NOTICES *

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CLAIMS

[Utility model registration claim]
[Claim 1] The lighting circuit for electric-discharge lamps characterized by having connected the capacitor to said reactor and forming a resonance circuit in the lighting circuit for electric-discharge lamps which connected the reactor and the electric-discharge lamp to the serial between the output terminals of the bridge circuit which consisted of two or more switching elements.
[Claim 2] the lighting circuit for electric-discharge lamps given in "claim 1" in which said reactor has a primary coil and a secondary coil.

[Translation done.]

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TECHNICAL FIELD

[Industrial Application]
This design is related with lighting circuits for electric-discharge lamps, such as a metal halide lamp (HID lamp) and a mercury-vapor lamp.

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PRIOR ART

[Description of the Prior Art]
As shown in drawing 5 , as for the conventional lighting circuit for electric-discharge lamps, the reactor 8 and the electric-discharge lamp 7 are connected to the serial between the output terminal 15 of the bridge circuit which consisted of the 1st as two or more switching elements - 4th FET (field-effect transistor) 3-6, and 16. The trigger generating circuit 9 is connected to the electric-discharge lamp 7 at juxtaposition.
[0003]
While impressing direct current voltage between the input terminal 1 of a bridge circuit, and 2, the on-off action of the 1st and 4th FET 3 and 6 and 2nd and 3rd FET 4 and 5 is carried out by turns, and a square wave electrical potential difference is generated between the output terminal 15 of a bridge circuit, and 16. Impress the trigger pulse electrical potential difference of 4kV or more to a electric-discharge lamp 7 by the trigger generating circuit 9 at this and coincidence, and a electric-discharge lamp 7 is made to ignite, rectangular current is passed to a electric-discharge lamp 7 and a reactor 8, and they are made to turn on a electric-discharge lamp 7. A reactor 8 prevents the high frequency component of rectangular current which flows to a electric-discharge lamp 7, and attains stabilization of the optical output of a electric-discharge lamp 7.

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EFFECT OF THE INVENTION

[Effect of the Device]
According to this design, circuitry is simple, and since the lighting circuit for electric-discharge lamps with few components mark can be obtained, it becomes possible about a lighting circuit a miniaturization and to lightweight-ize and to reduce a manufacturing cost.

[Translation done.]

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Device]
By the way, in the conventional lighting circuit for electric-discharge lamps, since the trigger generating circuit 9 which generates the trigger pulse electrical potential difference of 4kV or more was separately needed in order to make a electric-discharge lamp 7 ignite, circuitry was complicated, components mark increased and there was a fault with difficult miniaturization and lightweight-izing. This fault has been the failure of manufacture cost reduction, and is not desirable.
[0005]
Then, this design aims at offering the lighting circuit for electric-discharge lamps which can simplify circuitry and can reduce components mark.
[0006]

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MEANS

[Means for Solving the Problem]
The lighting circuit for electric-discharge lamps by this design connects a reactor and a electric-discharge lamp to a serial between the output terminals of the bridge circuit which consisted of two or more switching elements, connects a capacitor to said reactor, and forms the resonance circuit. The reactor of the example of illustration has a primary coil and a secondary coil.

[Translation done.]

* NOTICES *

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OPERATION

[Function]

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OPERATION

[Function]
If the on-off action of two or more switching elements is carried out by turns, respectively and a square wave electrical potential difference is generated between the output terminals of a bridge circuit while impressing direct current voltage between the input terminals of the bridge circuit which consisted of two or more switching elements, it will flow to the resonance circuit where the impulse current which synchronized at the time of the standup of a square wave electrical potential difference and falling consisted of a reactor and a capacitor. According to this impulse current, a resonance circuit resonates, a high-pressure trigger pulse is generated, and it is impressed by the electric-discharge lamp. By this, rectangular current flows to a electric-discharge lamp and a reactor at the same time a electric-discharge lamp is ignited, and a electric-discharge lamp lights up. For this reason, the separate circuit which generates a high-pressure trigger pulse can become unnecessary, and circuitry can be simplified, and components mark can be reduced.

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EXAMPLE

[Example]
Hereafter, the example of the lighting circuit for electric-discharge lamps by this design is explained based on drawing 1 - drawing 3 . However, in drawing 1 , the same sign is given to the same part as the part shown in drawing 5 , and the explanation is omitted.
As the lighting circuit for electric-discharge lamps of this example is shown in drawing 1 , the series circuit of 1st and 2nd FET (field-effect transistor) 3 and 4 is connected between an input terminal 1 and 2, and the series circuit of 3rd and 4th FET 5 and 6 is connected to the series circuit of 1st and 2nd FET 3 and 4, and juxtaposition. Of this, the bridge circuit which makes the join of the source terminal of 1st FET3 and the drain terminal of 2nd FET4 and the join of the source terminal of 3rd FET5 and the drain terminal of 4th FET4 output terminals 15 and 16 is formed. The 1st - 4th FET 3-6 will be used as a switching element, and will be from an OFF state in an ON state by impressing an electrical potential difference to the gate terminal of each FET. At this example, as shown in drawing 2 (A) and (B), the on-off action of 1st and 2nd FET 3 and 4 is carried out on the frequency of about 200Hz, i.e., the period of 5ms, by turns, and as shown in drawing 2 (C) and (D), the on-off action of 3rd and 4th FET 5 and 6 is carried out on the frequency of about 30kHz, i.e., the period of 33.3 microseconds, by turns. FET shows an ON state at the time of 0V, and, as for the electrical potential differences VDS1-VDS4 between the drain-sources of the 1st - 4th FET 3-6, FET shows the OFF state at the time of a high-level electrical potential difference. Thus, the square wave electrical potential difference of about 200Hz is generated between the output terminal 15 of a bridge circuit, and 16. In addition, as shown in drawing 2 , in order to prevent that it will be in an ON state, i.e., a power-source short circuit condition, at coincidence at the time of each on-off change rate of 1st and 2nd FET 3 and 4 and 3rd and 4th FET 5 and 6, the dead times 20 and 21 which make an OFF state FET 3 and 4 and FET 5 and 6 at fixed time amount coincidence, respectively are formed. Moreover, between an output terminal 15 and 16, the primary coil 10 and electric-discharge lamp 7 of a reactor 12 are connected to the serial. What has discharge electrodes used as for example, a lamp for video projectors, such as a metal halide lamp (HID lamp) and a mercury-vapor lamp, is used for a electric-discharge lamp 7. Between an output terminal 15 and an input terminal 2, the secondary coil 11 and capacitor 13 of a reactor 12 are connected at a serial, and the resonance circuit is formed. The winding direction of the primary coil 10 of a reactor 12 and the secondary coil 11 is the winding direction where

reverse, i.e., a mutual inductance, serves as a negative value mutually. Moreover, the turn ratio of the primary coil 10 and the secondary coil 11 is N1:N2, and has the relation of N1>N2.

[0009]

Next, actuation of the lighting circuit for electric-discharge lamps of drawing 1 is explained based on drawing 2 and drawing 3 .

If about [200-300V] direct current voltage is impressed to input terminals 1 and 2 and 1st and 4th FET 3 and 6 is made into an ON state, a current will flow in 1st FET3, the secondary coil 11 of a reactor 12, and the path of a capacitor 13. The wave of this current is an impulse wave and only very slight time amount flows. When this impulse current flows and resonates to the secondary coil 11 and capacitor 13 of a reactor 12, as shown in drawing 3 (A), in the both ends of the secondary coil 11 of a reactor 12, the alternating voltage 30 with the maximum peak value equal to applied voltage occurs. Moreover, when 2nd and 3rd FET 4 and 5 changes to an ON state, in order to emit the energy stored in the capacitor 13 in the secondary coil 11 of a reactor 12, and the path of 2nd FET4, the maximum peak value is equal to applied voltage, and the alternating voltage 31 of an opposite phase occurs in alternating voltage 30. At this time, in the both ends of the primary coil 10 of a reactor 12, as shown in drawing 3 (B), the N1/twice (N1/N 2> 1) as many N [as this] alternating voltage 32 and 33 of applied voltage occurs [the maximum peak value] in an opposite phase with drawing 3 (A). A high-pressure trigger pulse is generated by the alternating voltage 32 and 33 generated to the both ends of the primary coil 10 of a reactor 12, it is impressed by the electric-discharge lamp 7, and a electric-discharge lamp 7 is ignited.

[0010]

If the on-off action of the 1st - 4th FET 3-6 is carried out as shown in drawing 2 (A) - (D) at the same time a electric-discharge lamp 7 is ignited, the electrical potential difference of the direction via which it goes at the half period (2.5ms) of the beginning of drawing 2 (A) in order of 1st FET3, the primary coil 10 of a reactor 12, a electric-discharge lamp 7, and 4th FET6 will occur between an output terminal 15 and 16. Here, if the electrical potential difference of this direction is made into the electrical potential difference of the forward direction, in the next half period of drawing 2 (A), 3rd FET5, a electric-discharge lamp 7, the primary coil 10 of a reactor 12, and the electrical potential difference of the direction via which it goes in order of 2nd FET4, i.e., the electrical potential difference of the negative direction, will occur between an output terminal 15 and 16. By this, the square wave alternating voltage of about 200Hz occurs between an output terminal 15 and 16, square wave alternating current flows to the primary coil 10 of a electric-discharge lamp 7 and a reactor 12, and a electric-discharge lamp 7 lights up. Since the electrical potential differences impressed to a electric-discharge lamp 7 at this time are an output terminal 15 and an electrical potential difference which deducted a part for the voltage drop of the primary coil 10 of a reactor 12 (drawing 3 (B)) from the electrical potential difference between 16, the maximum peak value of the electrical potential difference of a electric-discharge lamp 7 is given by the following formula. The voltage waveform 34 of the both ends of a electric-discharge lamp 7 is shown in drawing 3 (C).

[Equation 1]

$$\left(1+\frac{N_1}{N_2}\right)\times \text{印加電圧}$$

In addition, although 3rd and 4th FET 5 and 6 is carrying out the on-off action by turns with the period of 33.3 microseconds between 1 periods (5ms) of drawing 2 (A) as shown in drawing 2 (C) and (D), the electrical potential difference between an output terminal 15 and 16 does not become intermittent according to the self-inductance effect of the primary coil 10 of a reactor 12.

[0011]

As mentioned above, since the secondary coil 11 and capacitor 13 of a reactor 12 can constitute the circuit which generates a high-pressure trigger pulse from this example, it becomes possible to simplify circuitry and components mark can be reduced.

[0012]

The embodiment of this design is not limited to the aforementioned example, but various modification is possible for it. For example, although the example of illustration showed the example to which switching operation of the 1st and 2nd FET 3 and 4 and 3rd and 4th FET 5 and 6 is carried out by turns on the frequency of 200Hz and about 30kHz, respectively, switching operation of the 1st and 3rd FET 3 and 5 and 2nd and 4th FET 4 and 6 may be carried out by turns on the frequency of 200Hz and about 30kHz, respectively. It is not necessary to say that each switching frequency is not limited to 200Hz and about 30kHz. It is good also as the same in all the switching frequencies of the 1st - 4th FET 3-6. Moreover, other switching elements, such as the usual assembling-die power transistor and SCR (reverse inhibition 3 terminal thyristor), may be used instead of FET (field-effect transistor). Furthermore, although the aforementioned example showed the example which uses the reactor 12 which has the primary coil 10 and the secondary coil 11, as shown in drawing 4 , a capacitor 13 may be connected to a center tap using the reactor 14 which has a center tap.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The electrical diagram of the lighting circuit for electric-discharge lamps showing the example of this design
[Drawing 2] The wave form chart showing the electrical potential difference between the drain-sources of each FET (field-effect transistor)
[Drawing 3] The wave form chart showing the electrical potential difference of each both ends of a primary coil, a secondary coil, and a electric-discharge lamp
[Drawing 4] The electrical diagram of the lighting circuit for electric-discharge lamps showing other examples of this design
[Drawing 5] The electrical diagram showing the conventional lighting circuit for electric-discharge lamps
[Description of Notations]
1 Two [.. A reactor, 9 / .. A trigger generating circuit, 13 / .. 15 A capacitor, 16 / .. Output terminal] .. An input terminal, 3-6 .. The 1st - the 4th FET (switching element), 7 .. A electric-discharge lamp, 8, 12, 14

[Translation done.]